WO8805336

Publication Title:

A CIRCULATION FLUIDIZED BED REACTOR

Abstract:

A circulating fluidized bed reactor (1) having a cyclone separator (4), the horizontal vortex chamber (3) of which is provided with two return ducts (9, 11) for separated particulate material. The first return duct (9) is connected to an opening (8) on the periphery of the vortex chamber and disposed near the gas inlet channel (6) in axial direction. The second return duct (11) is connected to another opening (10) disposed at a distance from the first duct near the discharge opening (7) for the purified gas in axial direction.

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B01J 8/24, B04C 3/06

A1

(11) International Publication Number: WO 88/ 05336

(43) International Publication Date: 28 July 1988 (28.07.88)

(21) International Application Number: PCT/FI87/00013

(22) International Filing Date: 21 January 1987 (21.01.87)

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(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent), SU, US.

Published
With international search report.

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(57) Abstract

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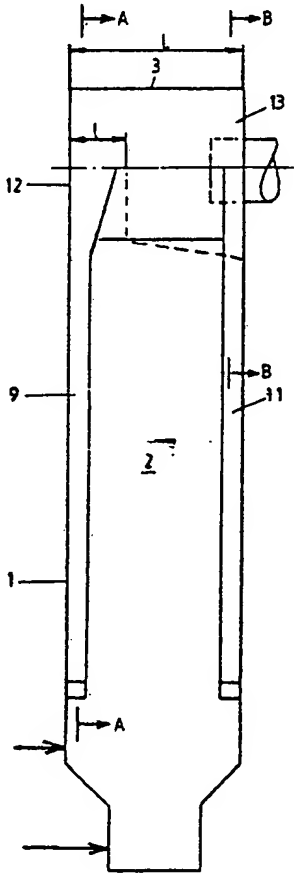

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A circulating fluidized bed reactor

The present invention relates to a circulating fluidized bed reactor in which solid particles are conveyed by gas through the reactor and separated from the gas by means of a cyclone separator or a similar device and returned to the reactor.

Today circulating fluidized bed reactors are more and more applied in various uses such as chemical processes, combustion and gasifying.

The object of the invention is to accomplish a circulating fluidized bed reactor, in which solid material can effectively be separated from the flue gas and returned to a required place in the reactor.

According to the invention this is achieved by means of a cyclone separator for separating particulate material from the flue gases from the reactor chamber, the horizontal vortex chamber of which being provided with openings on its periphery to which openings is connected a duct leading gas from the reactor chamber and a return duct leading separated solid material to the reactor chamber and from which vortex chamber gas is discharged from one or both ends, wherein one discharge opening for separated solid material is disposed by the inlet opening for gas and the other by the discharge opening for purified gas at a distance from the inlet opening in the longitudinal axial direction of the vortex chamber.

FI patent application 841126 discloses a circulating fluidized bed reactor in which solid material is separated by means of a horizontal cyclone disposed on top of the reactor. To the periphery of the separation chamber of the horizontal chamber is connected a return duct for separated material, preferably to the lowest part of the periphery, and the purified gases

are discharged from one or both ends of the separation chamber. The separated solids are discharged from the separation chamber via one opening that stretches over its whole width.

In the known application of the horizontal cyclone separator the discharge opening for solid material and the inlet opening for gas stretching over the whole width disturb the flow condition in the separation chamber.

In the apparatus according to the invention in which the separator is provided with two discharge openings spaced a distance apart from each other, most of the dust coming into the cyclone is separated due to centrifugal force already during the first cycle and is discharged from the vortex chamber via an opening disposed by the inlet opening for the gas. The remaining dust load is relatively small and cannot essentially decelerate the gas vortex formed in the cylone, thus the effect of the vortex remains good throughout the cyclone. The rest of the dust that can be separated is discharged via an opening disposed at the other end of the cyclone. Separation of the remaining dust takes place in an undisturbed flow condition in such a part of the vortex chamber where there are no openings on the periphery. By means of the design according to the invention the separation efficiency of a horizontal cyclone is improved, which efficiency is, as known, lower than that of a conventional vertical cyclone, but there are economic advantages compared with a circulating fluidized bed reactor having a conventional vertical cyclone.

When most of the whirling mass is removed from the beginning of the horizontal cyclone, the rest of the cyclone will wear

more slowly (the amount of the remaining whirling mass is smaller and an average grain size is smaller).

The invention will be described further, by way of example, with reference to the accompanying drawings in which

Fig. 1. shows one embodiment according to the invention as a side view,

Fig. 2. shows a section along the line A-A of Fig. 1,

Fig. 3. shows a section along the line B-B in Fig. 1,

Fig. 4. shows another embodiment according to the invention as a side view and

Fig. 5. shows a section along the line C-C in Fig. 4.

In figures 1-3 is shown a circulating fluidized bed reactor, on top of a vertical reactor chamber 2 of which is disposed a cyclone separator 4 provided with a horizontal vortex chamber 3. Gases leaving the upper part of the reactor chamber are led to the vortex chamber by means of a tangentially connected duct 5 that is connected to a gas inlet opening 6 disposed on the periphery of the vortex chamber in the vicinity of one of its ends 12. The width l of the gas inlet opening 6 is smaller than the width L of the vortex chamber, which width is as large as that of the reactor chamber. In the other end 13 of the vortex chamber there is a gas outlet opening through which the purified gases are discharged. A first discharge opening 8 for separated solid material is disposed by the gas inlet opening in the direction of the longitudinal axis, but on the opposite side of the vortex chamber. A first return duct 9 for solid material functioning as a discharge pipe is connected to the discharge opening 8. At the other end of the

vortex chamber a second discharge opening 10 for separated solid material is disposed at a distance from the first discharge opening 8 in the direction of the longitudinal axis. A second return duct 11 is connected to this second discharge opening. The lower ends of both return ducts are connected to the lower part of the reactor chamber. Fluidizing gas, for example combustion air, is led in a way known per se to the lower part of the reactor.

Most of the solid material that is discharged with the flue gas from the upper part of the reactor chamber is separated at the gas inlet end of the vortex chamber and returned to the lower part of the reactor via the return duct 9. The rest of the solid material that can be separated is separated at the end near the gas discharge opening 7 and returned via the return duct 11. Purified gases are discharged from the vortex chamber via the opening 7 that can be connected to a heat recovery apparatus.

In the embodiment according to the invention shown in figures 4 and 5, the width L of the separator of the vortex chamber 23 disposed on top of the reactor chamber 22 is larger than the width of the reactor chamber, consequently the vortex chamber stretches partly over the convection part 24 located beside the reactor chamber. Due to the large width an effective separation of solid material from the flue gas is accomplished. The width l of the duct 25 leading to the vortex chamber and of the inlet opening 26 is as large as the width of the reactor chamber. The solid material separated on the periphery of the vortex chamber is returned to the lower part of the reactor chamber via return ducts 29 and 31, of which one is connected to an opening 28 by the gas inlet opening and the other to an opening by the gas outlet opening. The purified gas leaving through the gas discharge opening 27 is led via a duct 32 to the convection part.

The invention is not intended to be limited to the embodiments presented here as examples only but it can be modified and applied within the scope of the protection defined by the patent claims. For example, the vortex chamber can be conical in its longitudinal section or is can be formed by two cylindrical parts of different sizes connected by a conical part. The number of return ducts can be larger than two. The purified gas can be discharged from both ends of the vortex chamber.

Claims

1. A circulating fluidized bed reactor having a vertical reactor chamber and a cyclone separator for separating particulate material from the flue gases from the reactor chamber, the horizontal vortex chamber (3, 23) of which being provided with openings on its periphery to which openings is connected a duct (5, 25) leading gas from the reactor chamber and a return duct (9, 11; 29, 31) leading separated solid material to the reactor chamber and from which vortex chamber gas is discharged from one or both ends, c h a r a c t e r i z e d in that one discharge opening (8, 28) for separated solid material is disposed by the inlet opening (6, 26) for gas and an other (10, 30) by the discharge opening (7, 27) for purified gas at a distance from the inlet opening in the longitudinal direction of the vortex chamber (3, 23).

2. A circulating fluidized bed reactor as claimed in claim 1, c h a r a c t e r i z e d in that one discharge opening (8) for separated material has been disposed at one end (12) of the vortex charber and the other (10) at its other end (13).

3. A circulating fluidized bed reactor as claimed in claim 1 or 2, c h a r a c t e r i z e d in that the vortex chamber (3, 23) is disposed on top of the reactor chamber (2, 22).

4. A circulating fluidized bed reactor as claimed in claim 3, c h a r a c t e r i z e d in that the width (L) of the vortex chamber ~~(3~~, 23) is greater than the width (l) of the reactor chamber (22).

5. A circulating fluidized bed reactor as claimed in claim 4, c h a r a c t e r i z e d in that the vortex charber (23) reaches at least partly over a convection part (24) disposed beside the reactor chamber (22).

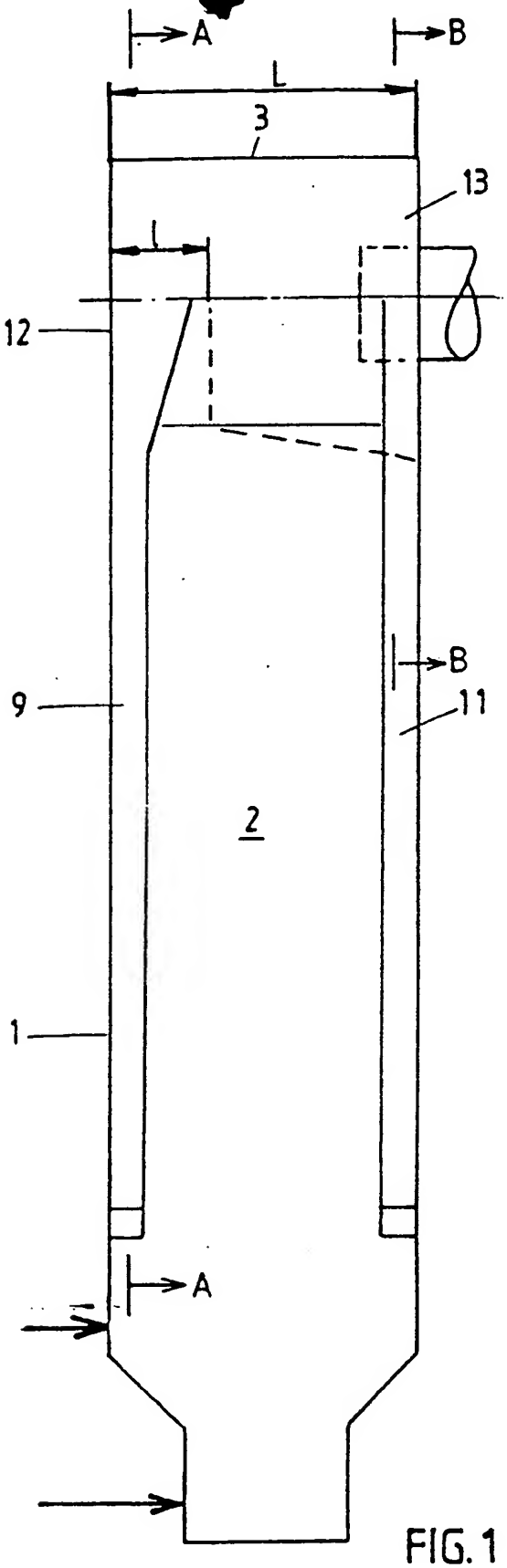

FIG. 1

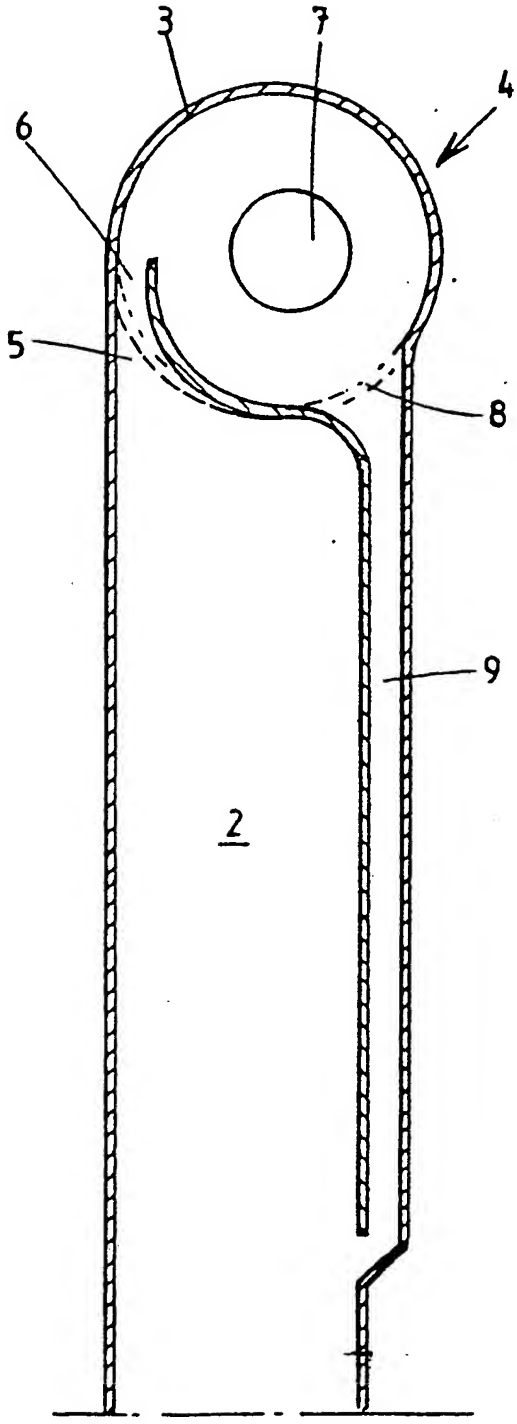

FIG. 2

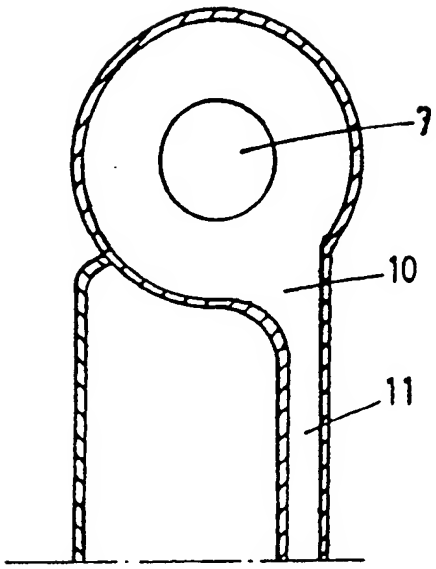

FIG. 3

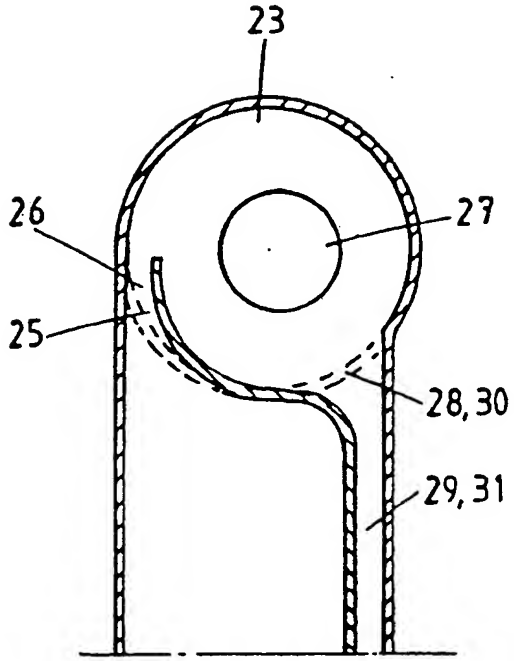

FIG. 5

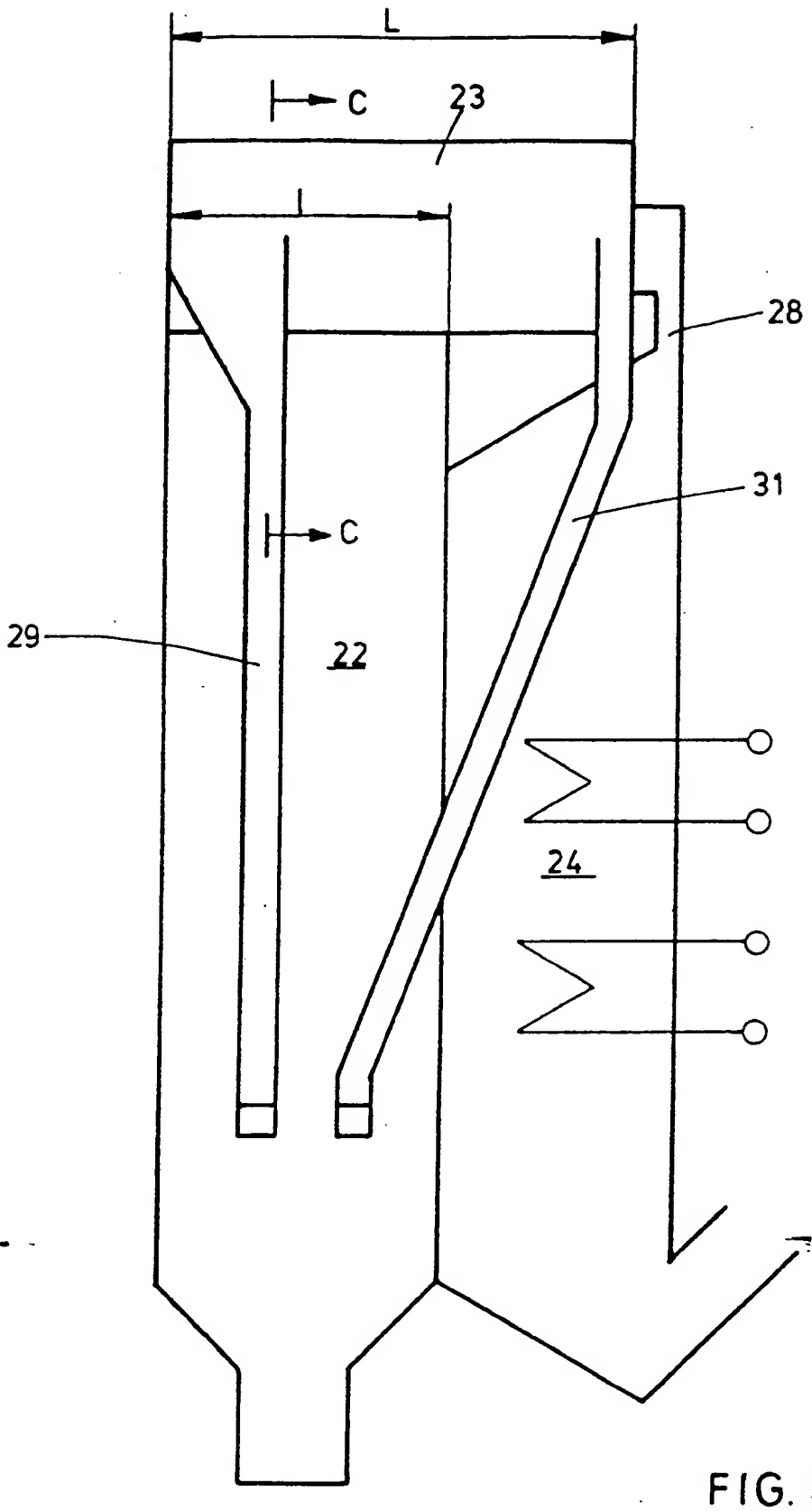

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI87/00013

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC [4]

B 01 J 8/24, B 04 C 3/06

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 1	B 01 J 1/00
IPC 4	B 01 J 8/14, /24, /36-/38; B 04 C 3/04, 9/00; F 27 B 15/10-/12 .../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X,Y	WO, A1, 86/04402 (A. AHLSTROM CORPORATION) 31 July 1986 & AU, 53946/86 JP, 61502834	1-3
A	US, A, 3 698 874 (FREDERICK A ZENZ) 17 October 1972	1, 3
A	FR, A, 1 325 323 (PREPARATION INDUSTRIELLE DES COMBUSTIBLES) 18 March 1963	1-3

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-07-27	1987 -08- 21
International Searching Authority	Signature of Authorized Officer
Swedish Patent Office	Bengt Christensson

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FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields Searched (cont).

US Cl 55:77, 447-458;
422:139-147

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This International search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.